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MAST CELL NUMBERS IN THE YOUNG RAT THALAMUS: A SEARCH FOR CONTROL FACTORS*

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Numbers of mast cells within brain space can be influenced by exposures to weak, complex magnetic fields. The present studies were designed to help isolate the factors that control numbers of mast cell within the thalamus ($n = 96$) of 15 and 20 day old rat pups. In Experiment I, rat pups were injected daily with either 1 microliter/g or 10 microliter/g of either distilled water, isotonic saline or 0.5 M saline; another group served as controls. The numbers of thalamic mast cells did not differ significantly between the four groups. In Experiment II, that employed a cross-fostering, split litter design, the rats whose mothers had consumed 0.9% taurine during pregnancy contained about twice as many mast cells within the thalamus compared to controls. Fifteen day old pups that had been reared by other mothers showed more mast cells than those reared by their own mothers. There were negative correlations ($-.60$) between the numbers of mast cells within the leptomeninges of the pups and the mothers' ovarian weights but no significant associations between the numbers of mast cells within the brains of the pups and the mothers.

Keywords: Mast cells; Brain; Taurine; Postnatal; Rats; Thalamus; Cross-fostering

There is a conspicuous concentration of mast cells within the thalamus of the young rat brain (Dropp, 1976; Persinger, 1977). The numbers of mast cells are sufficient to explain the concentration of histamine within the non-neural pool (Dropp, 1976; Persinger, 1981; Sabria *et al.*, 1987). Ontogenetic observations indicate that mast cells enter the brain

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through the leptomeninges and then migrate into the parenchyma during the period of fine angiogenesis (Persinger, 1981). Although there appears to be preferential destinations within particular thalamic groups, there is substantial individual variability between animals and between nuclear groups within animals.

The factors that control the rate of this migration (or appearance) or the numbers of mast cells have not been established. The work by Sabria *et al.* (1987) suggests that experimentally elevated thyroxine levels during post-natal days 1 through 4 substantially increase mast cell numbers and histamine levels within the rat brain. The majority of these mast cells would have been concentrated within the leptomeninges and would have involved minimal expression within the parenchyma.

Determination of the factors that control the numbers and ultimate distribution of mast cells within the brain is important. Mild, non-explosive releases of heparin and biogenic amines from brain mast cells have been postulated to affect the migration of sensitized lymphocytes into parenchyma by altering the permeability of the blood-brain-barrier (Persinger, 1977). Dietsch *et al.* (1987) have demonstrated that the delayed T-lymphocytic activity involved with experimental allergic encephalomyelitis can be modified following administration of agents that block mast cell degranulation. Recently Cook, Persinger and Koren (2000) found that the numbers of mast cells almost doubled within the thalamic region of female Lewis rats when they were exposed for about two weeks to amplitude modulated 40 Hz, 500 nT square wave magnetic fields for 6 min per hour, 8 hours per night during the development of experimental allergic encephalomyelitis.

These results suggest that understanding the factors that control the numbers of mast cells within the brain during development is important to predict the individual responsiveness of adult brains to environmental stimuli, such as complex magnetic fields. Several studies (Persinger, 1977b, 1979, 1980) have attempted to quantitatively determine the general ontogenetic and preweaning factors that control mast cell numbers within the thalamus. In general about 10% of the variance in thalamic mast cell numbers within the 15 and 20 day old rat brain can be accommodated by behavioral factors such as brief (5 min), daily handling. Age effects (the difference between 15 and 20 days) accommodated about 50% of the variance in mast cell numbers

within the thin layer of leptomeninges that covers the dorsal diencephalon. Litter differences accounted for between 20–30% of the variance in mast cell numbers within the parenchyma but had little effect on numbers within the leptomeninges.

To discern if we could further identify the controlling factors that affect mast cell numbers and their appearance in the thalamus, we designed two separate experiments. In Experiment I, rat pups were injected with various concentrations of saline. The selection of this stimulus was based upon the rationale that the copious but transient concentration of mast cells within the subfornical organ of the young rat pup might imply the role of mast cells in fluid balance or stress-mediated fluid retention. If this assumption was correct, then animals injected with hypotonic or hypertonic solutions should demonstrate different numbers of mast cells within this region.

In Experiment II, a split-litter, cross-fostering design was utilized to determine if a shift in the caregiver's (mother's) behavior and milk constituents might affect mast cell numbers in the pups. Half the pregnant females had consumed 0.9% taurine in the water during the 21 days of gestation while the other females consumed tap water. This oral concentration was selected because it had been shown to affect inhibitory behavior in adults and to elevate levels of taurine within the whole brain by about 15% compared to tap-water controls (Persinger *et al.*, 1976). Because we found no evidence in the literature that comparisons had been made between the thalamic mast cell numbers of the mother or her thymic weights (an inference of function) and the number of mast cells within the thalamus of the offspring, this question was addressed as well. Ferrer *et al.* (1979) had shown that the light regime to which the developing rat was exposed influenced mast cell numbers in the lateral geniculate bodies within the thalamus. Careful records were kept to determine if the eyes were opened or closed at the time of decapitation for the 15 day old rats.

METHOD

Sixteen litters were used in two separate experiments. A total of 96 rat pups and their 16 mothers served as subjects. The Wistar albino females (and breeder males) had been obtained from Woodlyn

Suppliers (Guelph, Ontario). After two weeks of habituation to the new colony conditions, they were bred. Within 24 hr of birth, each litter was culled to 8 pups.

In Experiment I, 32, 15-day old albino Wistar rats and 32, 20-day old pups from 8 litters and their mothers were employed as subjects. Starting at 10 days of age, 2 pups (one male and one female) from each of 8 litters received one of 4 treatments: hypotonic saline (distilled water), isotonic saline (physiological saline), hypertonic saline (0.5 M NaCl) or no injection (controls). All injections were intraperitoneal (i.p.) and were delivered with a 500 microliter syringe. The control animals were pricked with the injection needle but not injected. Four of the litters received 1 microliter/g of one of the fluids while the other 4 received 10 microliter/g. To maintain the identity of each rat, it was marked according to the procedure of Persinger (1979). All injections were made between 1300 and 1700 hr local time during the midportion of the colony's light cycle. Handling and housing procedures have been described elsewhere (Persinger, 1980).

In Experiment II 4 mothers consumed 0.9% taurine in the water supply from the time of impregnation (as determined by sperm plugs) until they delivered while the other 4 mothers consumed water. At birth half the numbers of pups from each of any two (water-taurine) litters born on the same day were earmarked and placed with the other litter whose mother had been given the alternative treatment. The pups that remained with their own mothers were marked on the opposite ear. For each pair of litters, the ear that was marked to designate the mother's own pups was reversed. Sixteen pups (2 from each litter; one male and one female when possible) that had not remained with their biological mothers and 16 rats that had been fostered were selected for the study.

Forty-eight (48) pups were killed by decapitation in Experiments I and II on postnatal day 15 and another 48 pups were killed on postnatal day 20. Careful developmental records were maintained during Experiment I to determine if the eyes of the 15 day old pups were closed, partially opened or completely opened on the day of decapitation. Cerebrums were quickly removed and fixed in ethanol-formalin-acetic acid. In addition, the mothers' brains were removed and the wet weights of their pituitaries, thyroids, thymuses, spleens, ovaries and adrenal weights were measured.

After fixation and processing, the brains were sectioned (10 micrometers) and stained with toluidine blue O. Four sections at the level of: (a) the geniculate bodies, (b) the posterior habenulae, (c) the midthalamic nuclei and (d) the anterior nuclei and subfornical region were examined. The entire surface of each section was traversed at 400 X; total numbers of mast cells were determined separately in (a) the diencephalic leptomeninges and (b) the thalamic parenchyma. Because of the large range in numbers of mast cells per section, all analyses were conducted on raw data and the square root of the numbers of mast cells when appropriate.

For Experiment I, the primary analysis involved a 5-way analysis of variance with two factors repeated. The three main (between subjects) levels were salinity (control, hypo-, iso- and hyper-salinity), age (15 *vs.* 20 days) and injection volume (1 cc/kg *vs.* 10 cc/kg) while the two within subject (repeated) measures were the four levels of the neuraxis (geniculate through subfornical organ) and location (leptomeninges *vs.* parenchyma). Two way analyses of variance was completed for the numbers of mast cells for the 15 day old pups only. They included within subject (level of neuraxis) and between subjects (eyes opened, partially closed, or closed) levels.

The primary analysis for Experiment II was a three way analysis of variance for mast cell numbers within the parenchyma and leptomeninges separately as a function of prenatal treatment (0.9% taurine *vs.* tap water), age (15 *vs.* 20 days), and whether they had been reared by their own mothers or had been fostered by another. Spearman correlations were completed between the numbers of mast cells within the thalamus of the mothers' brains and their tissue weights as well as the mean number of mast cells within the thalamus of their respective pups.

RESULTS

Experiment I

Photographs of mast cells are shown in Figures 1 and 2. Mast cells were conspicuous by their dense metachromatic staining and cytoplasmic granules. In general the dense rounder mast cells were distributed along the leptomeninges. The mast cells with clearly

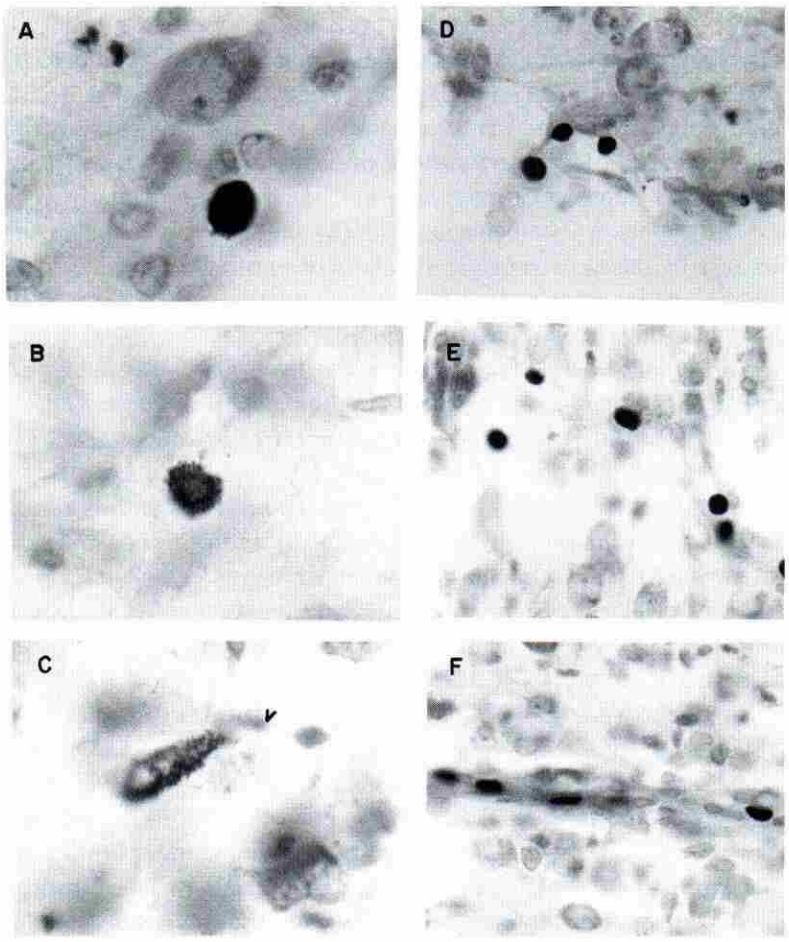

FIGURE 1 (A) Mast cell (MC) near the boundary of the thalamus adjacent to the leptomeninges. (B) MC with granules within the subfornical organ, (C) MC adjacent to a capillary (V), (D) three MCs along the leptomeninges, (E) several MCs near the interface with the subfornical organ, (F) MCs along a blood vessel within the thalamus. A-C (400 X), D-F (100 X). Toluidine blue O.

defined granule networks were most frequently observed around blood vessels within the thalamus or adjacent to vasculature penetrating into the parenchyma from the leptomeninges.

The means and standard deviations for the numbers of thalamic mast cells per 10 micrometer for the various conditions are shown in

FIGURE 2 Distended mast cell with granules adjacent to capillary. The larger fainter cells surrounded by darker perimeters are neurons within the thalamus. 1000 X (oil immersion) Toluidine blue O.

Table I. The means of the square root of the numbers of mast cells per 10 micrometer section and the standard error of the means are shown in Figure 3. The square root transformation was utilized to minimize the heterogeneity of within and between group variance.

The results of the 5-way analysis of variance indicated no statistically significant group differences between the four salinities

TABLE I Means and standard deviations for the numbers of thalamic mast cells per 10 micrometer section for various conditions in Experiment I

	Volume				*Age*			
	1*cc/kg*		10 *cc/kg*		15 *days*		20 *days*	
Source	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
leptomeninges	41	28	49	28	66	26	25	8
parenchyma	35	31	32	25	23	22	44	31
	Concentration							
	Control		Isotonic		Hypotonic		Hypertonic	
leptomeninges	48	32	41	21	49	32	44	29
parenchyma	32	24	37	36	30	23	36	30

[$F(3,48) = .02$, $p > .05$] or volume of injection [$F(1,48) = .35$, $p > .05$]. [The statistically significant F values are shown for the numbers of mast cells and their square root transformations, respectively.] *Post hoc* analysis of the statistically significant three-way interaction [$F(3, 144) = 29.68$; 22.64 $p < .001$] between the level along the neuraxis, the age of the rats, and the leptomeninges *vs.* the parenchyma indicated that this effect was due primarily to the greater number of mast cells within the leptomeninges at the level of the subfornical organ. The statistically significant interaction between location of the mast cells within the leptomeninges or parenchyma and age [$F(1,48) = 90.53$; 119.60, $p < .001$] was due in large part, according to *post hoc* analysis, to the relatively larger numbers of mast cells within the leptomeninges of the 15 day old pups compared to the 20 day old pups while the numbers of mast cells within the parenchyma did not demonstrate any statistically significant age differences.

The numbers of mast cells within thalamic parenchyma were significantly associated with whether or not the eyes were opened or closed at the time of decapitation. As noted in Table II rats that had their eyes opened (even within the same litter) displayed more mast cells within the thalamic parenchyma ($F(2,45) = 4.52$, $p \leq .01$). The effect was due in large part to the highly significant ($p \leq .001$) interaction between eye condition (closed, partially-opened, and opened) and the level of neuraxis ($F(6,133) = 11.72$, $p < .001$). Rats that had opened their eyes by the day of decapitation displayed more mast cells at the level of the geniculate bodies compared to those rats

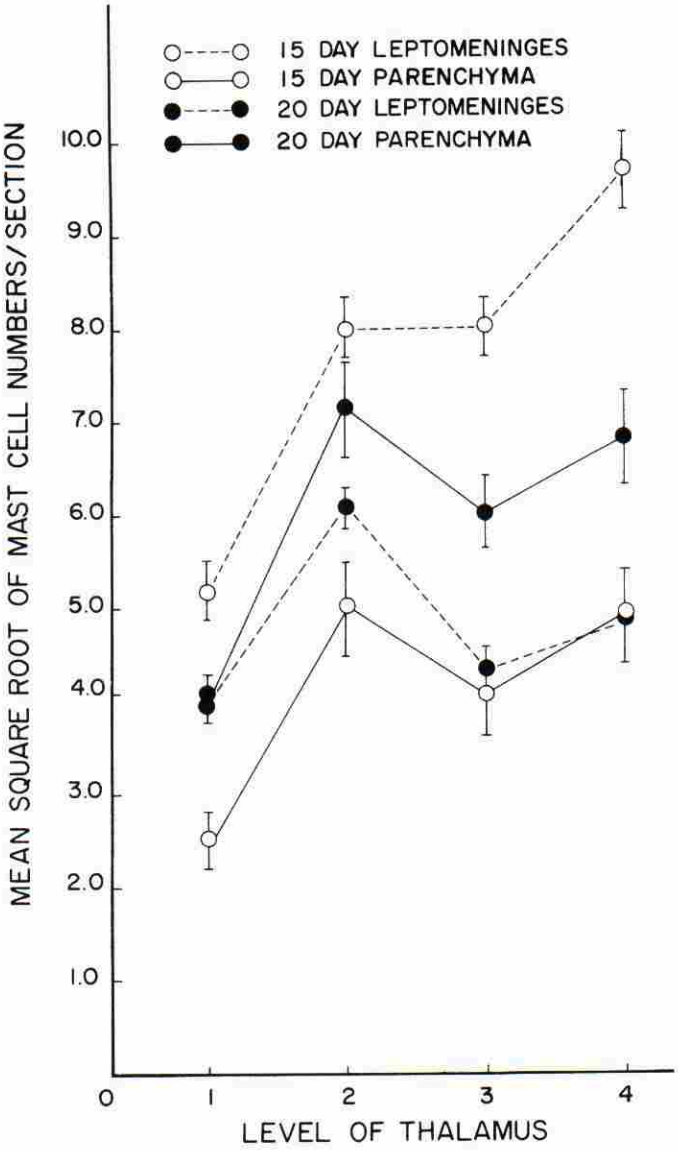

FIGURE 3 Means of the square roots of the numbers of mast cells per 10 micrometer section within the leptomeninges and parenchyma of 15- and 20-day old rats as a function of different ascending levels (see text) of the thalamus. Vertical bars indicate standard errors of the mean.

TABLE II Means and standard deviations for the square root of the numbers of thalamic mast cells per 10 micrometer section for the pups with eyes opened ($n=17$), partially opened ($n=5$), or still closed ($n=10$) when killed at 15 days of age

	Leptomeninges						*Parenchyma*					
	Closed		*Partial*		*Opened*		*Closed*		*Partial*		*Opened*	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Level												
medial gen.	4.9	1.2	4.7	1.7	5.6	1.7	1.4	1.1[a]	1.6	1.0[a]	3.5	1.6[b]
habenula	7.6	1.8	7.5	2.6	8.5	1.8	3.6	1.4[a]	3.9	2.1[a]	6.1	2.9[b]
midthal.	7.5	1.5	7.9	2.7	8.3	1.7	3.1	1.5	3.4	2.0	4.9	2.7
ant. nuc.	9.8	2.7	9.2	2.4	9.7	2.5	3.8	2.0	4.1	2.5	5.8	2.4

that had their eyes closed or only partially opened; the latter two groups did not differ significantly from each other. In addition there was no significant difference in mast cell numbers between any of the groups at the more anterior thalamic levels. The degree of eye-opening had no statistically significant effect on the numbers of mast cell numbers within the leptomeninges.

Experiment II

The means and standard deviations for the numbers of mast cells within the leptomeninges and parenchyma as a function of prenatal treatment (tap water *vs.* 0.9% taurine), age (15 *vs.* 20 days) and postnatal condition (own mother *vs.* another mother) are shown in Table III. Three way analysis of variance as a function of prenatal treatment, age, rearing condition for the numbers of mast cells within the leptomeninges indicated that the rats whose mothers had consumed taurine contained more mast cells [$F(1,24)=33.99$, $p<.001$] than the rats whose mothers had consumed tap water.

There was a statistically significant interaction between age and postnatal (rearing) condition [$F(1,24)=8.03$, $p<.01$]. *Post hoc* analysis showed that 15 day old pups reared by other mothers displayed more mast cells within their leptomeninges than those reared by their own mothers (regardless of taurine or water treatments) while the reverse pattern occurred for the 20 day old pups. The means (and standard deviations in parentheses) for the numbers of mast cells in the leptomeninges for the 15 and 20 day old pups reared by their own mothers were 66 (22) and 38 (28), respectively. These values for the 15

TABLE III Means and standard deviations for the numbers of mast cells within the leptomeninges and thalamic parenchyma as a function of prenatal treatment, age, and postnatal rearing condition

		Leptomeninges		*Parenchyma*	
Main Effects	*n*	*M*	*SD*	*M*	*SD*
Prenatal Treatment					
Tap Water	16	39	30	4	6
0.9% taurine	16	74	46	10	8
Age					
15 days	16	83	43	5	6
20 days	16	30	22	9	9
Postnatal Rearing					
Own Mother	16	52	28	9	10
Foster Mother	16	61	53	6	6

and 20 day old pups raised by other (foster) mothers were 99 (49) and 21 (12) respectively. There was also, as expected, the statistically significant [$F(1,24) = 35.54$, $p < .001$] main effect for age due the fewer numbers of mast cells for within the leptomeninges of the older compared to the younger rats.

Three way analysis of variance demonstrated that the rats whose mothers had consumed taurine exhibited significantly more mast cells [$F(1,24) = 9.33$, $p < .01$] in the parenchyma (but not the leptomeninges) of the thalamus compared to the rats whose mothers had consumed tap water. The 20 day old rats contained more parenchyma mast cells [$F(1,24) = 4.19$, $p = .05$] then did the 15 day old rats. The statistically significant interaction [$F(1,24) = 15.72$, $p < .001$] between the prenatal condition (taurine *vs.* water) and rearing condition (own *vs.* other mother) was due primarily to the reduction in numbers of mast cells within the litters whose mothers had consumed taurine but were reared by mothers who had not consumed taurine. The means and standard deviations for total parenchyma mast cells per section for pups from litters whose mother had consumed taurine, and who were reared by their own or other mothers were 16 (9) and 5 (4), respectively, while these values for pups whose mothers had consumed tap water, and were reared by their own or other mothers who had consumed taurine displayed values of 2 (1) and 6 (7), respectively.

The last analysis involved correlations between the measures from all 16 mothers. Male and female rat pups that had not been fostered from each of the 8 litters in Experiment II and male and female rats

pups from the 8 litters in Experiment I exhibited statistically significant ($df = 15$, $p \leq 0.05$) correlations between the numbers of thalamic parenchyma mast cells (but not the numbers of leptomeningeal mast cells) and the mothers' thymus weights. The correlation coefficients (*rho*) for the 15 and 20 day old male pups were 0.55 and 0.65, respectively while these values for the 15 and 20 day old females were 0.60 and 0.68, respectively.

However the mothers demonstrated a significantly negative (-0.65) correlation between their thymus weights (M = .269 mg; SD = .059 mg) and their own parenchyma thalamic mast cell numbers. The numbers of mast cells were M = .4, SD = .5 within the leptomeninges and M = 37, SD = 12 within the parenchyma. There were no statistically significant correlations between the numbers of mast cells within the thalamus of the mothers and the thalamus of their pups.

In addition, there were no significant correlations between the numbers of mast cells within the thalamus of either the pups or their mothers and the mothers' body weights (M = 296 g, SD = 33 g), pituitary weights (M = .013 mg, SD = .002 mg), spleen weights (M = .464 mg, SD = .258 mg), thyroid weights (M = .015 mg, SD = .002 mg), or adrenal weights (M = .190 mg, SD = .251 mg). Mast cell numbers in only the leptomeninges of both 15- and 20-day of male pups were negatively correlated (-0.60 and -0.61, respectively) with the mothers' ovarian weights (M = .121 mg, SD = .020 mg). Comparable values of $-.57$ and $-.73$ were observed for the female pups. The organ weights of the mothers were not significantly correlated with the body weights of the pups for either the 15 day (M = 35 g, SD = 2 g) or the 20 day (M = 50 g, SD = 2 g) groups.

DISCUSSION

Our results demonstrated that the numbers of mast cells within the main body of the thalamus as well as the overlaying leptomeninges of preweaned rats can be affected by experimental manipulation. The thalamic space of rats whose mothers had consumed taurine during their pregnancy, compared to controls, contained about twice the numbers of mast cells within both the leptomeninges and the parenchyma. Taurine is noted for its capacity to sequester calcium

(Huxtable, 1976). Fazzini *et al.* (1992) reported that the phenylephrine-induced increase in intracellular calcium in cardiomyocytes was reduced in a dose-dependent manner by taurine. Because calcium plays an essential role in signal transduction during regulation of process related to the ontogeny and mitosis of cells, it is possible that this maternal treatment may have affected the division of mast cells or their precursors during prenatal development.

Although one might expect prenatal diets (particularly those influencing important amino acids such as taurine) to affect the growth of the brain and hence the numbers of mast cells, the impact of cross-fostering upon the numbers of these cells within the postnatal brain was more surprising. The greater numbers of mast cells within the leptomeninges of 15 day old pups reared by foster mothers compared to pups reared by their own mothers indicate that the process of cross-fostering can influence the presence of these potent histamine and heparin containing cells. That this effect was reversed (fewer leptomeningeal mast cells) in 20 day old pups reared by foster mothers suggests that very significant changes in biochemistry within the leptomeninges of fostered pups but not the biological pups occurred within the five days between postnatal day 15 and day 20. This occurred even though the transference of the pups and their litter mates had occurred almost two weeks previously.

The destination of leptomeningeal mast cells is not clear. The numbers of mast cells appearing within thalamic nuclei are not the inverse or mirror image of the numbers of mast cells disappearing from the overlaying leptomeninges. There appears to be a loss of the total numbers of these cells between their disappearance from the leptomeninges and their appearance in the thalamic parenchyma. The results of this study indicated that cross-fostering influenced the numbers of leptomeningeal mast cells but not the mast cells emerging within the parenchyma. Whether or not different subpopulation of leptomeningeal mast cells, some of which do not penetrate into the thalamus, are affected by different stimuli must still be examined.

Mast cells whose numbers had increased in the parenchyma of rats whose mothers had consumed taurine were reduced by maternal care from surrogates. This suggests but does not prove that degranulation may have occurred. If degranulation, rather than failure to emerge within the thalamus, was responsible for the reduced numbers than

stimuli as subtle as minor changes in caregiving could encourage the release of histamine, heparin and proteins from these cells into thalamic space. Infiltrations of immunologically stimulated cells, such as lymphocytes, might also occur.

We have one documented case of a 20 day old Wistar rat, a strain in which experimental allergic encephalomyelitis is not easily induced, that displayed multiple foci of lymphocytes around blood vessels throughout the right thalamus. There were no mast cells within this region although a few residual metachromatic granules were evident. Yet the left thalamus of this rat displayed the normal, copious numbers of perivascular mast cells and no evidence of infiltration of lymphocytes.

In our unpublished studies completed during 1983 we found that 15 and 20 day old pups that had been exposed only one hour per day for five days to a 0.5 Hz rotating magnetic field with intensities between .1 mT and 1 mT displayed about twice the numbers of mast cells with extruded granules compared to rats exposed to sham field conditions. There was no significant change between the exposed and control groups for the numbers of thalamic mast cells.

Cook *et al.* (2000) found that numbers of mast cells increased within the thalamus of adult female Lewis rats that were exposed for 15 consecutive nights to much weaker magnetic fields, within the 500 nT (5 mG) range, whose amplitude modulations of 7 Hz square waves was varied every 7 sec to 14 sec during a 6 min period once every hour during the late scotophase. Whether or not the thalamus of rat pups, during the time of the most active ontogenetic appearance of mast cells, would show an even greater response to these weak fields must still be discerned.

The possibility that weak, complex magnetic fields can both encourage the presence of mast cells around vasculature and facilitate their degranulation has important epidemiological implications. Relationships between diseases associated with transient disruptions of the blood-brain-barrier and some types of power frequency magnetic fields might be explained. The "electromagnetic sensitivity syndrome" (Beal, 1998) shares similarities with myalgic encephalomyelitis in humans and the behaviours of rats exposed to subclinical or electrical seizures (Cook and Persinger, 1999). Myalgic encephalomyelitis has been associated with specific hypometabolism within the

thalamus while subclinical seizures were associated with a surprising infiltration of lymphocytes into tract systems that connect the cingulate gyrus within the hippocampus and hypothalamus.

The failure of daily injections of even large volumes (equivalent to 10 cc/kg) of strong, non-isotonic saline to affect the numbers of mast cells suggests they are influenced by specific more than non-specific stimuli. However comparison of the means of the numbers of mast cells within the parenchyma of the thalamus between the first and second experiment showed a difference of almost a factor of five. One interpretation is that the treatment of the control group, which was handled daily and pricked in the abdomen (but not injected) was sufficient to increase the numbers of mast cells. If this explanation is valid, then the numbers of mast cells have a maximum value within the thalamus and this value can be evoked by relatively weak somatic stimulation or the biochemical consequences of daily disturbances of the nest.

The clear increase in the numbers of mast cells within the level of the geniculate bodies but not more rostral thalamic structures for pups whose eyes were opened at the time of decapitation compared to those pups whose eyes were closed or partially closed is compatible with a relationship between cerebral maturity and the migration of mast cells into the thalamus. Relatively early eye opening due to early hyperthyroidism or experimentally elevated thyroxine levels has also been shown (Sabria *et al.*, 1987) to substantially increase the numbers of mast cells numbers in thalamus. If thyroxine levels increase numbers of mast cells then conditions that promote thyroid activity might also increase that organism's sensitivity to stimuli that elicit degranulation.

We did not exam the thyroids of the rat pups or their mothers histologically. Lafreniere and Persinger (1979) found that neither perinatal nor adult exposures to 0.5 Hz rotating magnetic fields with intensities between 10 nT and 1 microT significantly affected the numbers of mast cells or numbers of follicles within the thyroid. These exposures also did not affect either the percent binding of T3 or the concentration of T4 (thyroxine) within the serum. However in light of the reports of marked recovery of individuals who show depression and sleep disruptions when proximal to power frequency magnetic fields after administration of T3 (Beal, 1998), these studies might be

replicated employing more temporally complex magnetic fields, particularly during the night phase of activity (Cook *et al.*, 2000; Persinger *et al.*, 1999).

Tissue weights do not necessarily reveal function. However the thalamic space of the mothers in this study displayed more mast cells if their thymuses were smaller. Reduced thymic weights would be consistent with the hypothesis that more intense alterations in cellular immunity coupled with pregnancy, lactation, and caregiving result in the proliferation of numbers of mast cells within the mother's brain. It may be of interest that partial immunosuppression, such as encountered during normal pregnancy, is associated with increased numbers of mast cells while periods of immunofacilitation, such as during the early stages of some demyelinating diseases, is associated with the degranulation of mast cells.

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